Laser-Plasma X-ray Sources and their Applications

Davide Boschetto, Kim Ta Phuoc, Antoine Rousse, *Laboratoire d'Optique Appliquée ENSTA/Ecole Polytechnique, 91761 Palaiseau cedex, France.* E-mail: davide.boschetto@ensta.fr

The time scale of elementary atomic motion is of the order of 100 fs (1 fs=10^{-15} s), which corresponds therefore to the first instants of the material response to an external excitation. When an ultra-short laser pulse can trigger a dynamics, a pump-probe experiment allows the measurement of transient state during photo-induced transition in the material. The new tool of femtosecond X-rays diffraction allow a direct monitoring of the atomic position, giving at the same time the required spatial and temporal resolution.

In this talk we will show on one side the first type of femtosecond X-ray source, based on the laser-plasma interaction on solid target [1], together with the most important experiments that were performed with it: the non-thermal melting in semiconductor [2], and the direct measure of the coherent atomic vibration (optical phonon) [3].

The second part of this talk concerns the new type of X-ray source based on a relativistic laser-plasma interaction on gas target, called "betatron" source. This source produces an X-ray beam that is polychromatic, highly collimated and whose duration is about 25 fs. The applications of this type of source will also be shown (time-resolved EXAFS, time-resolved Laue diffraction), together with a comparison with other existing pulsed X-ray sources.

[1] Rischel C., Rousse A., et al., *Nature*, 1997, **390**, 490-492. [2] Rousse A., Rischel C., et al. *Nature*, 2001, **410**, 65-68. [3] Sokolowski-Tinten K., et al., *Nature*, 2003, **422**, 287.

Keywords: time-resolved X-ray diffraction, phase transitions and structure, laser plasmas